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(54) **Device for simulating a vehicle crash**

(57) A device for simulating vehicle crashes which has a test sled (10), crash test dummy (14), and a pre-impact force generating device. The pre-impact force generating device can apply force directly to the crash test dummy, thereby overcoming many of the cost problems associated with applying a low and long duration force directly to a test sled (10). The pre-impact force generating device can be designed such that instead of providing a low and long duration force to a crash test dummy. It provides a short and high impact force to the crash test dummy. An impact force-generating device provides impact force directly to the sled to simulate a crash.

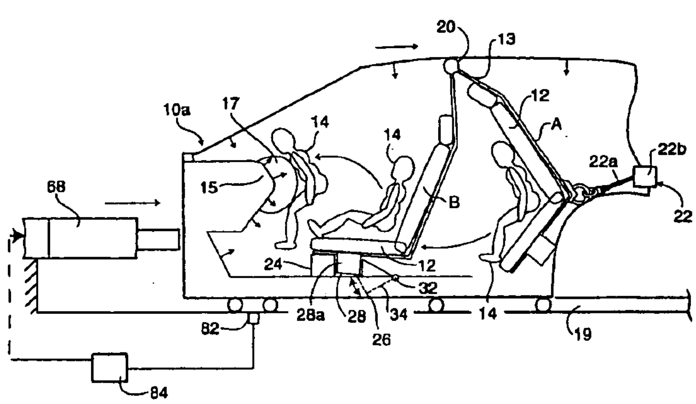

Fig. 4

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Description

[0001] The present invention relates generally to a vehicle crash testing device.

[0002] Current vehicle crash test devices do not account for "pre-impact" events. Typically, before a vehicle crashes, either the driver of the vehicle applies the vehicle brakes in anticipation of the crash or the vehicle collides with some smaller obstacle such as a curb before crashing into a larger object. The result of either of these occurrences is the generation of a pre-impact force or acceleration on the vehicle occupant. This pre-impact force causes the vehicle occupant to move from a pre-impact seated position to a modified position. This movement may be characterized by the occupant pivoting or sliding forward and may result in a reduction of the normal force and frictional forces acting between the occupant and the seat. This position is referred to as a "pre-impact position". This pre-impact repositioning could place the vehicle occupant in a more vulnerable out of position orientation immediately prior to the actual vehicle crash and may contribute to greater injuries sustained by the vehicle occupant.

[0003] In sled testing, a sled with a crash test dummy is accelerated to simulate the actual crash pulse that would occur for a particular vehicle. As used herein and in the claims the term "crash test dummy" is understood to mean a simulated vehicle occupant of the types well known in the crash test technology. Every aspect of this crash testing is designed to simulate, as close as possible, the actual conditions associated with a vehicle crash. In prior art test systems the test sled is either accelerated rearward at a level to match the deceleration of the vehicle crash (pulse) or the sled is accelerated forward and stopped at a proper deceleration level to match the vehicle crash pulse. In each of these test methodologies the crash dummy is positioned in a predetermined static seating position relative to the seat carried by the test sled. Prior art crash testing methods have not accounted for the effect of pre-impact conditions on the vehicle occupant The present invention, as set forth in the appended claim 1 overcomes this deficiency in the prior art.

[0004] Additional advantages and features of the present invention will become apparent from the subsequent description and the appended claims taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005]

FIGS. 1 through 3 diagrammatically illustrate a typical crash.

FIG. 4 is a schematic view of a pre-impact force generating device according to the present invention.

FIG. 5 is a schematic view of a second pre-impact force generating device according to the present invention.

FIG. 6 is a schematic view of a third pre-impact force generating device according to the present invention;

FIGS. 7a and 7b are schematic views of a pre-impact force generating device using a bungee sled in combination with an impact generating piston simulate pre-impact and crash conditions.

DETAILED DESCRIPTION OF THE INVENTION

[0006] FIGS. 1, 2, and 3 show a typical vehicle 10 during various phases of an actual crash. In FIG. 1 the vehicle 10 is shown moving forward at a velocity V. FIG. 2 illustrates a pre-impact phase of the crash during which the vehicle brakes are applied, or perhaps the vehicle has encountered a small barrier, (in trying to avoid the crash) such as a roadway curb prior to impacting another vehicle, tree, wall or other barrier 16. In response to the above, the forward velocity of the vehicle is slowed or decelerated. As the vehicle slows the vehicle occupant represented by a crash test dummy 14 accelerates forwardly, relative to a seat 12 toward the front of the vehicle. As used herein and in the claims the term "crash test dummy" is understood to mean a simulated vehicle occupant of the types well known in the crash test technology. The vehicle occupant will move to a "pre-impact position" relative to the seat 12 (as well as the other components within the passenger compartment). If this deceleration is high enough and the vehicle occupant is not restrained by a seat belt, the vehicle occupant could become dislodged from the seat. This pre-impact position is characterized by a re-positioning of the vehicle occupant as well as a reduction in normal load (and frictional forces) between the seat and the vehicle occupant. In an actual crash event, this pre-impact deceleration (which may arise due to brake application or some primary impact) is in the range of approximately 0.5 -1.2 g's sustained over a few seconds. This level of deceleration is considerably less than the deceleration that occurs during impact of the vehicle with a barrier. As is known in the art the actual level braking force, and resultant deceleration, that can be generated depends upon the forces that can be generated at the tire/road interface and will vary with actual road and driving conditions.

[0007] FIG. 3 illustrates the actual crash event in which the vehicle and vehicle occupant are subjected to a much higher level of deceleration. Were the vehicle occupant 14 not restrained he could be thrown from the seat 12.

[0008] FIG. 4 shows a first embodiment of the present invention used to simulate the pre-impact event. As mentioned above, during actual pre-impact condi-

tions the vehicle may experience a deceleration of about 1g over an extended duration. In the below-described embodiment of the invention, a simulated vehicle such as test sled 10a can held stationary (if only the pre-impact event is to be simulated) or subsequently accelerated to simulate the crash event. In the following embodiments of the invention the momentum transferred to the crash test dummy 14 is equivalent to that achieved during the actual pre-impact event such that the crash test dummy 14 will move at much the same pre-crash velocity as achieved in an actual vehicle crash. The method of simulating the pre-impact event is to preferably accelerate the crash test dummy 14 at a higher level of acceleration (of about 2 g's) than achieved during the actual pre-impact event but for a shorter period of time, in the range of 0 to 2 seconds (most preferably about 1 second). The use of applying forces directly to accelerate the crash test dummy overcomes the design difficulties associated with providing a long-duration force to simulate a slowing vehicle and vehicle occupant motion while still being able to position the crash test dummy 14 in a variety of the pre-impact positions without having to move the test sled over a long distance. The design of the test sled 10a permits the crash test dummy 14 to be placed in many determinable pre-impact positions with respect to impact sled 10, such as closer to the front of impact sled 10 (i.e. to the location of frontal air bags) or closer to the rear of impact sled, before final impact by varying the momentum transferred. Thus, to simulate this pre-impact positioning, a small pre-impact force can be applied to crash test dummy 14 for a lengthy period of time to move the crash test dummy closer to the front of the sled 10a. Likewise, a large pre-impact force can be applied to the crash test dummy for a short time to achieve the same positioning of the crash test dummy. It is noted that any variation to the force and time combination can be used which places the crash test dummy in its pre-impact position relative to the seat 12, and this invention is not limited to that disclosed herein. FIG. 4 illustrates an impact sled 10a which can be fabricated using a typical automobile, a section thereof or a known type of test sled buck.

[0009] The seat 12 is pivotally located on and movable with the impact sled 10a at pivot point 20. While the pivot point is shown generally near to or attached to the location of the roof of the simulated vehicle, i.e. the test sled, this pivot point can be located outside of the vehicle profile to provide a longer moment arm or alternately a lower pivot point location can be used. The seat 12 is secured to a cradle 13 which in turn is pivoted at 20. FIG. 4 shows the seat in both a "pivoted or actuated" position A and a "released" position B. The seat is maintained in position A by a release device 22 attached to the rear portion of seat and/or sled. As illustrated, the release device 22 includes a cable 22a linked to a solenoid 22b. Solenoid operated release devices and their attachments are well known in the art. The seat further includes a projection which serves as a mechanical seat stop 28. Extra weight 28a can optionally be added generally at the location of the stop 28 to achieve the desired terminal velocity or acceleration of the seat as it swings into position B. The sled 10a further includes a fixed mechanical stop 24 and a movable secondary stop 26 that retain the seat mounted stop 28 at position B. The secondary stop is pivoted about a pivot point 32 and is biased upwardly into the position shown in FIG. 4 by a spring 34.

[0010] Depending upon the conditions to be simulated, the crash test dummy may be positively secured to the seat using a conventional two or three point seat belt system which may be tightly or loosely secured about the crash test dummy. If unbuckled dynamic behavior is being investigated, the crash test dummy can be affixed to seat by VELCRO or other attachment means which provides sufficient force to keep the crash test dummy from sliding off seat due to gravitational forces when seat 12 is in position A. In a related alternative embodiment of the invention the pivoted structure need not be limited to the seat. In this embodiment the pivoted structure would include the entire forward portion of the passenger compartment including the seat (or seats) and the instrument panel.

[0011] In operation, a release device 22 is activated releasing the seat 12. Upon its release, the seat pivots about a pivot point 20 and thus moves from position A to position B permitting the seat and the crash test dummy 14 to accelerate to a determinable velocity and acceleration similar to that which would be achieved during an actual pre-impact event as illustrated in FIG. 2. A seat mounted stop 28 impacts secondary stop 26, thereby depressing the secondary stop 26 against the force of spring 34. This rotates secondary stop about pivot point 32, allowing seat mounted stop 28 to contact the stop 24 rapidly halting the motion of the seat. Immediately thereafter the secondary stop moves back into position trapping the seat mounted stop 28 between the fixed stop 24 and movable secondary stop 26. As a result of momentum transfer, the crash test dummy is urged away from the seat in the forward direction as shown and into the pre-impact position simulating the effect of the pre-impact force prior to the actual crash event as depicted in FIG. 3.

[0012] The dynamic effects of the actual crash event can also be simulated in conjunction with having first reoriented or repositioned the crash test dummy (simulated occupant) to its pre-impact position. As is known in the art test systems can be operated to simulate a crash event. There are two types of methodologies in use today. The first is generically called a deceleration sled in which a controlled piston is forcibly pushed into the front of a stationary test sled. The magnitude and speed of the impact of the piston with the test sled simulates the actual crash pulse of a particular vehicle. In the second method the test sled is propelled into a fixed barrier. This type of sled is often referred to

as a bungee sled as bungee cords or other springs are used to accelerate the sled. As the construction of these testing systems is well known they will not be described in any detail. However, FIG. 4 does illustrate the first of these test methods in which a controlled piston 68 is movably disposed in front of the test sled 10a. The piston and its associated mechanisms, in general, are a shock pulse generating device. The magnitude and duration of the shock pulse can be varied in a known manner to simulate the vehicle under test and the crash conditions. Activation of the piston causes the test sleda (which would be movably disposed upon a track 19 in a known manner) to accelerate rearwardly thereby causing the crash test dummy to move relatively forward toward the front of the vehicle closer to the dashboard or steering wheel, both of which are diagrammatically referred to by numeral 15 to the location of an air bag 17 (located in the steering wheel or instrument panel). The above system 80 may further include a sequencing device to synchronize the movement of the sled with the operation of the piston 68. Located on or near the track 19 is a motion detector 82. One such detector 80 may include a sonic or light beam device or the detector may include a mechanical switch. The motion detector detects movement of the front (or other area) of the test sled and provides a signal of such detection to a control unit 84. The control unit generates a signal to activate the piston. As can be appreciated the piston will not move into its active position (to pulse the sled) instantaneously, especially since it may be hydraulically or pneumatically charged. The motion sensor is appropriately placed to sense the movement of the sled prior to reaching its terminal position. The control unit 84 generates a control signal in relation to the inherent delay in the activation of the piston and continued movement of the sled (toward its terminal position) so that when the piston is activated it will be in its active position as the sled is at its terminal position. In this manner the crash test dummy will be positioned properly and the piston 68 will provide the correct crash pulse.

[0013] The operation of the entire system 80 is as follows. A control signal is sent to the solenoid device 23b releasing the seat 12. As a result of this, the crash test dummy 14 is caused to move to its pre-impact position as described above. The piston 68 is actuated to simulate the crash event so that it can supply the crash pulse when the crash test dummy is in its pre-impact position. Were the bungee type of test method used, the sled 10a would be accelerated towards a barrier. Prior to the impact of the sled with the barrier, the seat would be moved to place the crash test dummy in the pre-impact position.

[0014] A second embodiment of the present invention is illustrated in FIG. 5 wherein the seat 12 is movably mounted upon a track 38 that is incorporated into the sled 10a. The seat 12 slides on the track 38 between position A and a position B. One end of a spring 40 is fixedly attached to a structural member, such as the track, and another end is joined to a cable 42. The spring 40 can be any resilient device such as a bungee cord, rubber band, helical spring or any other device for applying tension. The cable wraps around a roller 44 and is then attached to the front of the seat 12. A release device 22 is again detachably connected to the seat. Retraction means are provided to move the seat from its released position A to position B against the force of the spring 40. This retraction means can include manually moving the seat or alternatively a motorized winch can be used. With the seat in its position B the release device 22 is operated to hold the seat in position B.

[0015] In operation, the release device 22 is activated to release the seat 12 directly accelerating the crash test dummy 14 forward to simulate the pre-impact conditions. More specifically, the spring 40 draws a cable 42 around a roller 44 and pulls the seat from position A to position B. The seat 12, when in position B, impacts stop 46 which may be part of the track 38. The impact of the seat against the stop 46 causes the crash test dummy to undergo simulated pre-impact acceleration with respect to the seat. As a result, the crash test dummy is urged into a pre-impact position relative to the seat. A crash force generator, such as a piston 68, can be activated to simulate the crash event as described above. The track 19 shown in FIG. 4 has been removed for clarity.

[0016] Referring to FIG. 6, a third embodiment of the present invention is shown which shows still another mechanism to directly accelerate the crash test dummy. In FIG. 6, the seat 12 is rigidly affixed to the impact sled 10a at supports 50. A fixture 56 is also rigidly attached to the sled by the supports 50. The fixture includes a rear plate 57 and a movable plate, or board 52. Springs 58 are supported by the fixture and interpose the rear plate 57 and the movable plate. The movable plate 52 is initially maintained in a pre-release position compressing the springs by a latch mechanism (not shown). The crash test dummy is initially positioned in a sitting position adjacent to the movable plate 52. On release of a latch mechanism the springs 58 expand and accelerate the plate 52 forward. As a result, the crash test dummy is urged into a pre-impact position. Crash forces can be applied as previously described.

[0017] Referring to FIGS. 7a and 7b, a fourth embodiment of the present invention is illustrated. Here, impact sled 10 is shown in two positions, FIG. 7a and 7b. A release device 22 is attached to impact sled 10 as shown. A bungee cord 62 has one end fixed to an external fixed point 64 and its opposite end is fixed to impact sled 10. The impact sled is slides on the track 66 by rollers or other means, allowing movement from the position in shown FIG. 7a to the position shown in FIG. 7b. Such engagement is well known in the art. A piston 68 is attached to fixed point 64 as shown.

[0018] Upon release of solenoid release device 22, the impact sled 10 is pulled by a bungee cord 62 from

the position in FIG. 7a to the position of FIG. 7b. A block 72, which is rigidly attached to track 66, stops the impact sled. Upon impact with the block, the crash test dummy 14 is urged forward, thereby simulating the pre-impact force and placing the crash test dummy in its pre-impact position. A piston 68 is then actuated and impacts the front of impact sled, thereby accelerating the impact sled rearwardly. This controlled and sudden impact approximates the vehicle specific crash pulse (magnitude and time) of a particular simulated vehicle causing the crash test dummy to move from its pre-impact position to an impact position.

Claims

1. A device for simulating a motor vehicle crash comprising an impact sled (10) having a seat (12) simulating a motor vehicle seat, said impact sled being selectively movable along a path in a first direction; a crash test dummy (14) being carried by said impact sled by said seat, said impact sled selectively accelerating said crash test dummy to a predetermined velocity along said path; characterized by a pre-impact force-generating device, said pre-impact force-generating device selectively exposing said crash test dummy to a pre-impact force, said pre-impact force simulating normal braking conditions experienced by a vehicle prior to a crash.

2. The device for simulating a motor vehicle crash as claimed in Claim 1 characterized by further comprising an impact force generating device, said impact force generating device selectively exposing said crash test dummy (14) and sled to an impact force, said impact force simulating a crash force of said motor vehicle (10) in a crash.

3. The device for simulating a motor vehicle crash as claimed in Claim 1 characterized by said pre-impact force generating device selectively applying said impact force to said crash test dummy, said impact force simulating a crash force of said motor vehicle) in a crash.

4. The device for simulating a motor vehicle crash as claimed in Claim 1 characterized by said pre-impact force generating device comprising:

   said seat (12) being pivotally mounted (20) relative to a surface of said impact sled (10);
   a release device (22) mounted to said impact sled 10 and being detachably connected to said seat (12); and
   a seat mounted stop (28) mounted to said seat (12) and having a test block stop (24) and secondary stop (26) for receiving said seat mounted stop 28 connected to said seat (12).

5. The device for simulating a motor vehicle crash as claimed in Claim 1 characterized by said pre-impact force generating device comprising:

   a track (38) allowing said seat (12) to move in a forward and a rear direction with respect to said impact sled (10);
   a spring loaded cable (42) drawing said seat (12) in said forward direction;
   a release device (22) selectively releasing said seat (12) to allow said spring loaded cable (42) to draw said seat (12) in said forward direction; and
   a seat stop (46) stopping said seat from moving along said track at a predetermined position.

6. The device for simulating a motor vehicle crash as claimed in Claim 1 characterized by said pre-impact force generating device comprising an impact sled stop (16) located along said path, said impact sled (10) selectively impacting said impact sled stop (16) to generate said pre-impact force.

7. The device for simulating a motor vehicle crash as claimed in Claim 1 characterized by further comprising an impact force generating piston (68) selectively exposing said impact sled (10) to an impact force, said impact force generating piston (68) accelerating said impact sled (10) after said impact sled (10) impacts an impact sled stop (72).

8. The device for simulating a motor vehicle crash as claimed in claim 1 characterized by said pre-impact force generating device comprises at least one spring loaded piston (58), said spring loaded piston (58) being attached to said seat (12), said spring loaded piston (58) selectively applying said pre-impact force to said simulated human (14).

9. The device for simulating a motor vehicle crash as claimed in Claim 1 characterized by said pre-impact force generating device generates a predetermined amount of pre-impact force for a predetermined amount of time to selectively position said crash test dummy at a predetermined location within said impact sled.

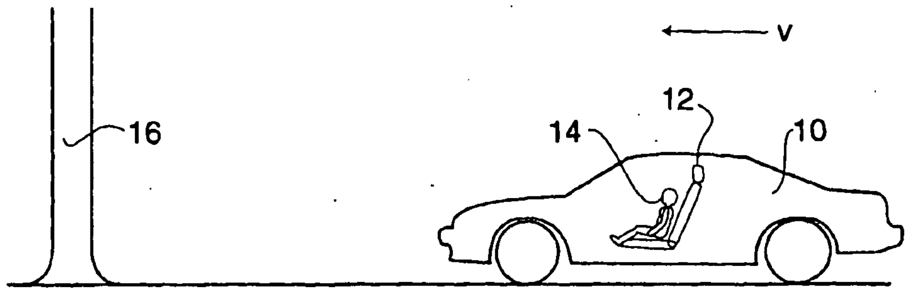

Fig. 1

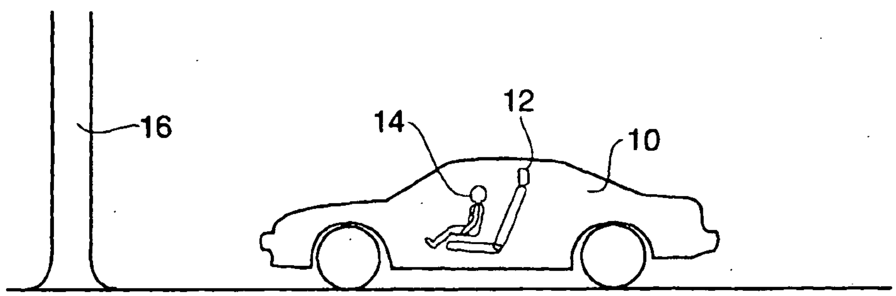

Fig. 2

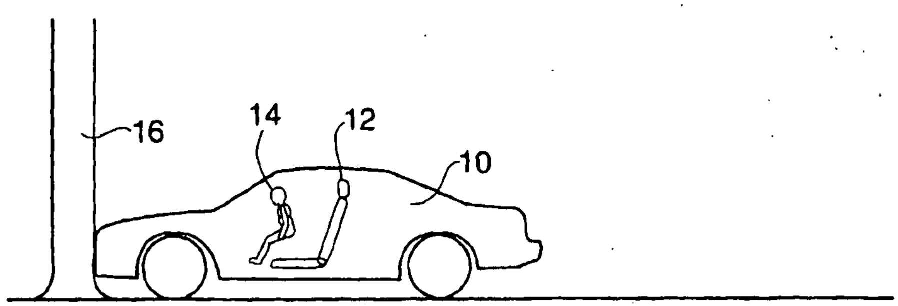

Fig. 3

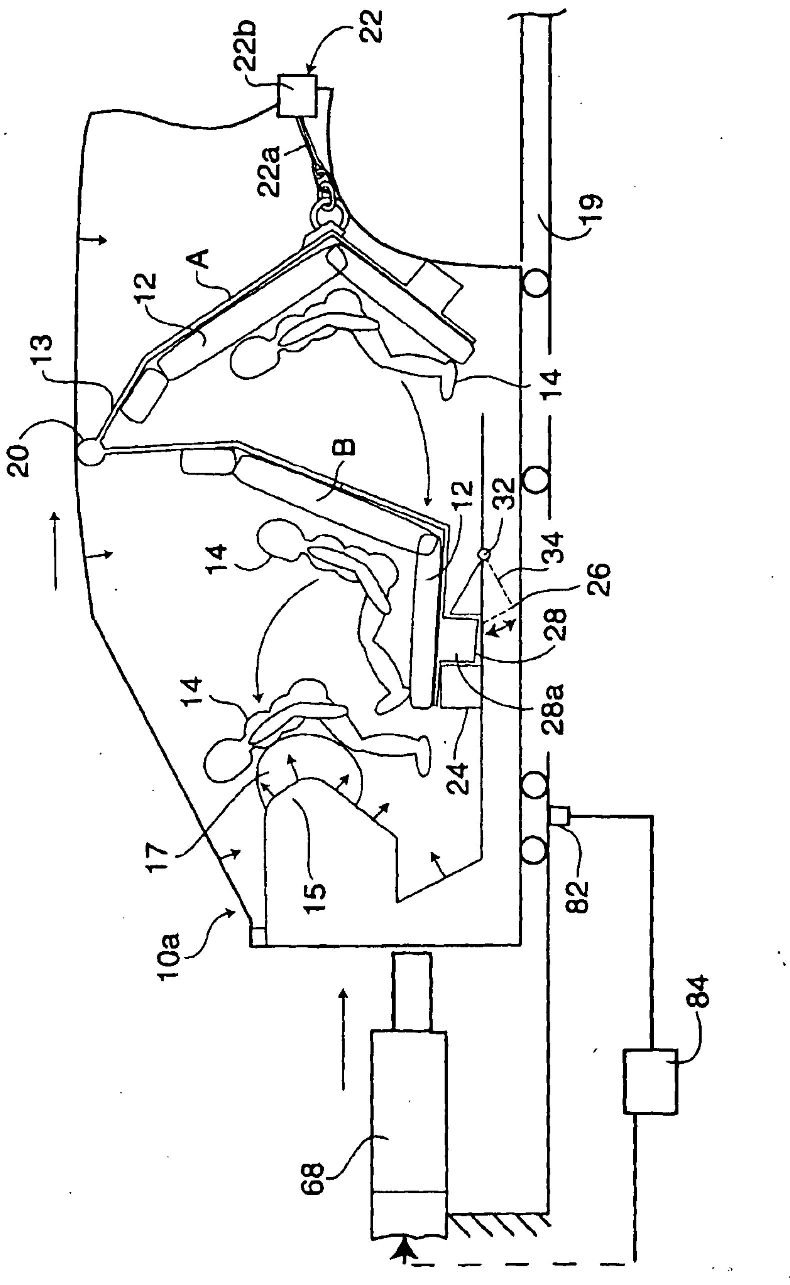
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Fig. 4

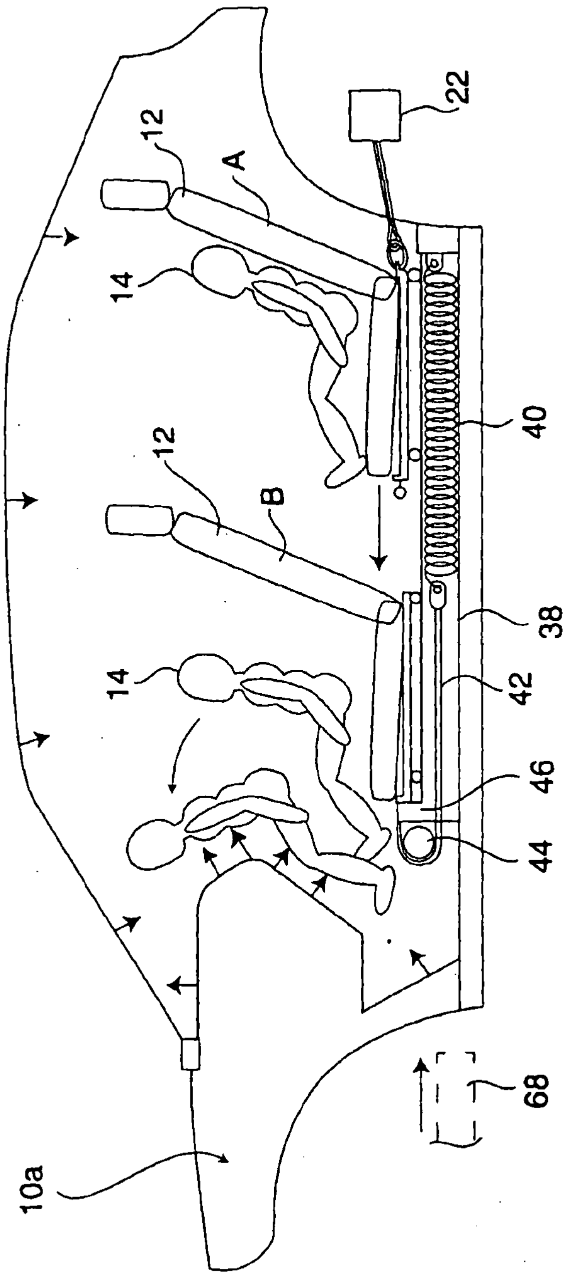

Fig. 5

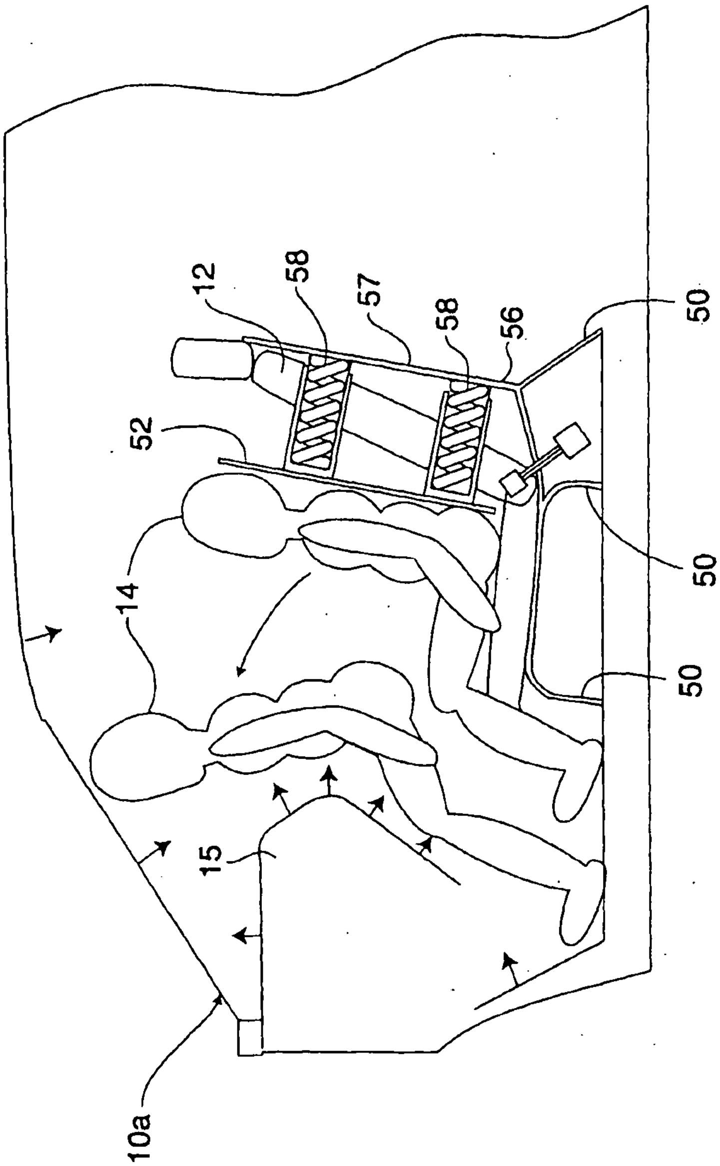

Fig. 6

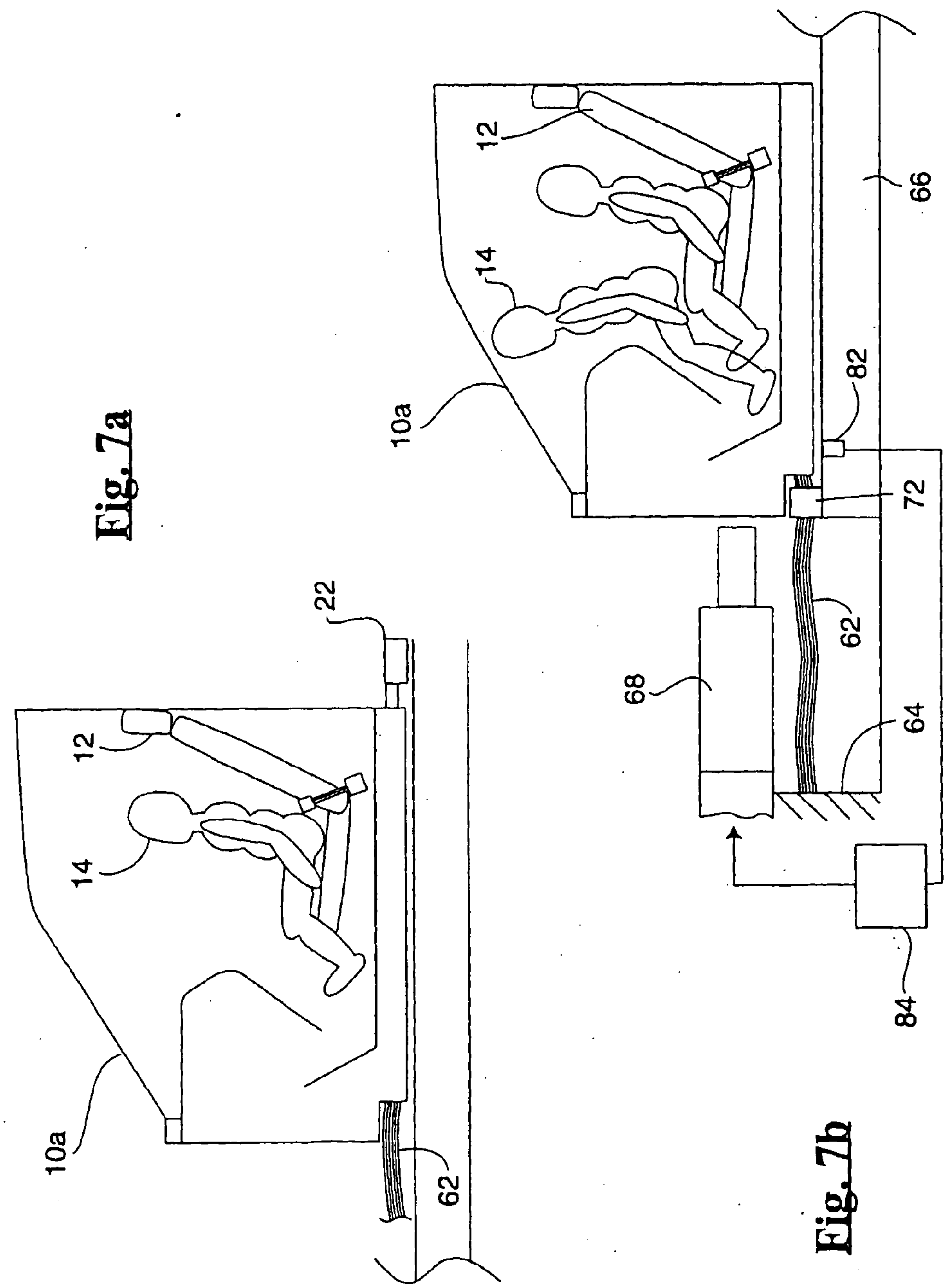

Fig. 7a

Fig. 7b